IAGC

Seismic Surveys and the Jet Engine: Myth vs Fact

MYTH: *The noise from seismic surveys is 100,000 more intense than a jet engine* (Oceana Claim).

FACT: ***The sound from seismic surveys is quieter than a jet engine.***

1. A seismic array, which is made up of many individual small sound sources or elements, operating together is not 100,000 times louder than a jet engine at takeoff.

2. Measured comparably in decibels, the sound from a jet engine is about the same level as a seismic array. However, the sound energy or power ("intensity") from a jet engine is considerably higher than a seismic array due to the longer duration and continuous nature of the jet engine sound compared to the short impulse nature of a seismic signal. (see Appendix for technical details on acoustic comparisons).

3. Seismic air signals near the source are impulsive consisting of short pulses less than 0.1 second long. In contrast, jet engine noise is continuous and therefore dangerous to hearing after only a few seconds of exposure without hearing protection.

4. The seismic industry employs various mitigation measures to decrease the potential effects of seismic operations on marine life. This includes the use of visual and acoustical monitoring and exclusion zones as well as soft-start procedures that give animals time to move away.

5. More than four decades of worldwide seismic surveys and scientific research have not shown evidence that sound from seismic operations results in significant negative impacts on marine life populations.

For More Information:

- IAGC, "Fundamentals of Sound in the Marine Environment," www.iagc.org/marineenvironment.
- BOEM final Atlantic OCS Programmatic Environmental Impact Statement, page C-19, www.boem.gov/Atlantic-G-G-PEIS/.
- OGP and IAGC, Fundamental of Underwater Sound, www.iagc.org/files/1120.
- OGP and IAGC, "An Overview of Marine Seismic Operations," www.ogp.org.uk/pubs/448.pdf.
- BOEM Science Notes, www.boem.gov/BOEM-Science-Note-August-2014/.
- Noise Sources and Their Effects, http://airportnoiselaw.org/dblevels.html.

Revised 9.24.14

Appendix

The Technical Reasons Why the Claim by Oceana is Misleading:

1. <u>Sound Pressure is the Standard Method for Measuring Sound</u>

   Oceana assumes that the decibel values given indicate intensity (power), but both the value provided for jet engines (140 dB) and the value provided for an air source array in water (250 dB) are sound pressure levels. In addition, the jet engine value is an average over time, whereas the air source array value is a peak value. Therefore, the two dB values cannot bet directly compared. The sound energy from a jet engine at takeoff is of longer duration, whereas the sound pulse from an air source array is short, and the comparison between the two is misleading at best.

   The unit for sound pressure is Pascal, but due to the wide range of levels encountered in measurement of sound, it is customary to describe these levels through the use of a logarithm scale. The most generally used logarithmic scale for describing sound is the decibel scale (dB). For the comparison in pressure, units of 20 are the appropriate divisor for comparing relative loudness on this logarithmic scale, not units of 10 as was done by Oceana.

2. <u>Different Reference Units Between Water and Air</u>

   A 250 dB sound in water is not the same as a 250 dB sound in air, just as zero degrees Centigrade is not the same as zero degrees Fahrenheit. Different reference levels are used for water measurements and for measurements in air.

   - Sound pressure measurements in water use a reference level of 1 micropascal, or "dB re 1 µPa".
   - Sound pressure measurements in air use a reference level of 20 micropascals, or "dB re 20 µPa." This corresponds to the lowest level of sound that the average human can hear.

   In addition to the difference in reference level, correction must also be made for differences in density and sound propagation velocity in air and in water. One cannot simply subtract or add a value reported in "dB re 1 µPa" to a value reported in "dB re 20 µPa." The difference in measurement units together with differences in the physical properties of air and water require that a 62 dB correction factor be added to any value reported for sound in air to make it comparable to the same sound pressure or intensity level in water. Therefore, the value provided for a jet engine's sound of 140 dB (in air) is equivalent to 202 dB (in water), all other things being equal. These and other inequalities (described below) are unaccounted for in the Oceana comparison.

3. <u>Different Distance Points Where Sound is Estimated</u>
   Sound pressure levels are usually calculated at a reference point of one meter. They may be measured at any distance, but for purposes of comparison they are usually back-calculated to a distance of 1 meter from the sound source. The sound level provided for the jet engine of 140 dB (air), or 202 dB (water), is from measurements taken at 100 feet or 30 meters from the engine itself, not one meter. A reasonable estimate of sound level loss going from 1 meter to 30 meters would be about 30 dB. Hence, the comparable sound level from a jet engine would be 170 dB in

air, or 232 dB in water.

Reported sound levels for a seismic array are on the order of 250 dB re 1 µPa (peak) in the downward direction. This corresponds to an average level of 230-240 dB re 1 µPa. The back-calculated sound level of a jet engine sound at 1 meter would be about 232 dB re 1 µPa in water. The most conservative theoretical estimate one could make is that the sound from a seismic array is comparable to one jet engine, but due to the much longer duration of the jet engine sound, this would be louder than the seismic array.

4. Actual Sound Pressure Levels from a Seismic Array are Lower than the Theoretical Array Output.

A seismic array is made up of a number of source elements, typically 20-30 or more. The elements are arranged to produce a synchronized addition of pulse fronts focused in the downward direction to look into the rock layers below the seabed. The reported levels for an array (e.g., 250 dB re 1 µPa (peak)) are based on a modeled back-calculation from that downward looking direction, as if the combined output had all come from one point. Actual maximum sound output is less than the modeled value, typically some 15 to 25 dB less, because the individual elements are spread out and lose energy before coming into synchrony below the array. As such, a theoretical array source level of 250 dB is not found anywhere, and the maximum output level is more on the order of 225-235 dB re 1 µPa (peak), or an average sound level of 205-215 dB re 1 µPa. This discrepancy between the theoretical and realized array sound output value is commonly referred to as the "array effect."

In directions other than the vertical, the source level of the seismic array is significantly less than the theoretical value; sound levels emanating horizontally from the sides of the array into the water are typically 20-30 dB or more below the sound levels directed downward. Furthermore, sound diminishes quickly as it radiates from the source. Sound pressure levels decline by half as the distance doubles, and the sound energy gets spread thinner and thinner. In other words, the sound from a jet engine is about the same level as a seismic array in the vertical downward direction, but in all other directions, the jet engine will sound significantly louder. And, as we have already noted, the jet noise is continuous and the seismic array is a very short pulse, which further reduces the perceived sound level of the seismic array relative to the jet engine.